非递归下降分析器

- 消除间接左递归方法

例：

$$S \to Qc|c$$
$$Q \to Rb|b$$
$$R \to Sa|a$$

过程：
(1)代入化简，将间接左递归变成直接左递归
将R的产生式代入Q的产生式，得到
$Q \to Sab|ab|b$
将Q的产生式代入S的产生式，得到
$S \to Sabc|abc|bc|c$
(2)消除直接左递归，得到的结果与Q和R无关，可删去Q和R的产生式
$S \to abcS'|bcS'|cS'$
$S' \to abcS'|\varepsilon$

- 简化文法，仅包含while循环的文法分析

注：忽略空格

$$(0)program \to block$$
$$(1)block \to \{stmts\}$$
$$(2)stmts \to stmt\ stmts$$
$$(3)stmts \to \varepsilon$$
$$(4)stmt \to id = expr;$$
$$(5)stmt \to while(bool)stmt$$
$$(6)stmt \to block$$
$$(7)bool \to expr\ bool'$$
$$(8)bool' \to < expr$$
$$(9)bool' \to <= expr$$
$$(10)bool' \to > expr$$
$$(11)bool' \to >= expr$$
$$(12)bool' \to \varepsilon$$
$$(13)expr \to term\ expr''$$
$$(14)expr'' \to expr'\ expr''$$
$$(15)expr'' \to \varepsilon$$
$$(16)expr' \to +term$$
$$(17)expr' \to -term$$
$$(18)term \to factor\ term''$$
$$(19)term'' \to term'\ term''$$
$$(20)term'' \to \varepsilon$$
$$(21)term' \to *factor$$
$$(22)term' \to /factor$$
$$(23)factor \to (expr)$$
$$(24)factor \to id$$
$$(25)factor \to num$$

- 手工构造分析表

	{	}	id	=	;	while	(	)	<	<=	>	>=	+	-	*	/	num
program	$program \to block$																
block	$block \to \{stmts\}$																
stmts	$stmts \to stmt\ stmts$	$stmts \to \varepsilon$	$stmts \to stmt\ stmts$			$stmts \to stmt\ stmts$											
stmt	$stmt \to \underline{block}$		$stmt \to id = expr;$			$while(bool)stmt$											
bool			$bool \to expr\ bool'$				$bool \to expr\ bool'$										$bool \to expr\ bool'$
bool'								$bool' \to \varepsilon$	$bool' \to < expr$	$bool' \to <= expr$	$bool' \to > expr$	$bool' \to >= expr$					
expr			$expr \to term\ expr''$				$expr \to term\ expr''$										$expr \to term\ expr''$
expr'													$expr' \to +term$	$expr' \to -term$			
expr''								$expr'' \to \varepsilon$	$expr'' \to \varepsilon$	$expr'' \to \varepsilon$	$expr'' \to \varepsilon$	$expr'' \to \varepsilon$	$expr'' \to expr'\ expr''$	$expr'' \to expr'\ expr''$			
term			$term \to factor\ term''$				$term \to factor\ term''$										$term \to factor\ term''$
term'															$term' \to *factor$	$term' \to /factor$	
term''								$term'' \to \varepsilon$	$term'' \to \varepsilon$	$term'' \to \varepsilon$	$term'' \to \varepsilon$	$term'' \to \varepsilon$			$term'' \to term'\ term''$	$term'' \to term'\ term''$	
factor			$factor \to id$				$factor \to (expr)$										$factor \to num$

- 求First集、Follow集

$$
\begin{aligned}
&First(program) = \{\ \{\ \} \\
&First(block) = \{\ \{\ \} \\
&First(stmts) = \{id, while, \{, \varepsilon\} \\
&First(stmt) = \{id, while, \{\ \} \\
&First(bool) = \{(, id, num\} \\
&First(bool') = \{<, <=, >, >=, \varepsilon\} \\
&First(expr) = \{(, id, num\} \\
&First(expr') = \{+, -\} \\
&First(expr'') = \{+, -, \varepsilon\} \\
&First(term) = \{(, id, num\} \\
&First(term') = \{*, /\} \\
&First(term'') = \{*, /, \varepsilon\} \\
&First(factor) = \{(, id, num\}
\end{aligned}
$$

$$
\begin{aligned}
&Follow(program) = \{\#\} \\
&Follow(block) = \{\#, id, while, (, \}\ \} \\
&Follow(stmts) = \{\ \}\ \} \\
&Follow(stmt) = \{id, while, (, \}\ \} \\
&Follow(bool) = \{)\} \\
&Follow(bool') = \{)\} \\
&Follow(expr) = \{), <, <=, >, >=\} \\
&Follow(expr') = \{+, -,), <, <=, >, >=\} \\
&Follow(expr'') = \{), <, <=, >, >=\} \\
&Follow(term) = \{+, -,), <, <=, >, >=\} \\
&Follow(term') = \{*, /, +, -,), <, <=, >, >=\} \\
&Follow(term'') = \{+, -,), <, <=, >, >=\} \\
&Follow(factor) = \{*, /, +, -,), <, <=, >, >=\}
\end{aligned}
$$